ENVIRONMENTAL RISKS ASSESSMENT OF COASTAL AREA IN THE SOUTH-EASTERN BALTIC SEA TO OIL POLLUTION

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Abstract

A low probability of oil pollution of coasts from two main potential sources located in the waters of Kaliningrad Region (Russian Federation) in the Baltic Sea is shown based on the results of modelling using Seatrack Web (SMHI, HELCOM). The most threatened areas of the coastal zone and coast, in the middle part of the Curonian Spit – UNESCO World Heritage site, as well as the distal part of the Vistula Spit and on the entire western coast of the Sambia Peninsula, were identified.

Keywords: risks of oil pollution, coastal area, Southeastern Baltic Sea, Seatrack Web

I. Introduction

Intensifying shipping, operation of oil terminals and offshore platforms poses a constant threat not only to coastal and socio–economic resources, but also to sensitive underwater landscapes of marine areas and vulnerable marine habitats [1].

The ship traffic in the Baltic Sea is among the most intensive in the world. The Baltic Sea area is a special area where any discharge of oil and oily mixtures is strongly prohibited (https://helcom.fi/action-areas/shipping/). Traffic accidents and illegal discharges from ships may pose high risks for the marine environment, thus co-actions to enhance maritime awareness and efficiency at sea seems to be the important challenge. Oil production from the offshore raises the risk of pollution accidents, which could have a devastating impact on the marine and coastal environment.

The purpose of this work was to assess the probability of oil pollution of the coastal area of Kaliningrad Region (Russian Federation).

II. Study area and methods

The main threat of oil pollution in the study area is oil extraction from Kravtsovskoye (D-6) oilfield located at a distance of 22.5 km from the Curonian Spit coast at the depths of about 30 m. In the case of accidental oil spill from the D-6 oilfield the major damage would be caused to the Curonian Spit [2, 3]. The Curonian Spit is a narrow, sandy peninsula of over 99 kilometers length,

separating the Curonian Lagoon from the open Baltic Sea. The northern part of the spit (52 km) belongs to Lithuania, and the southern one (46 km) – to Russia. Flat sandy beaches, protective dune ridges and near shore sandy spits are very valuable and attractive resources for human recreation and valuable habitat for wildlife [1, 4]. The national parks located on both sides of the Russian/Lithuanian border were added to the UNESCO's World Heritage List in 2000 (http://whc.unesco.org/en/list/994/documents/). The Curonian Spit National Park with adjacent waters is also referred to maritime cultural heritage of the Baltic Sea [4].

There are number of smaller villages located at the coast. Those do also have significant importance for developing recreational potential of the region. At present, both national parks include the adjacent sea area up to the 20 m isobaths as a rare biotope and wintering place for birds.

According to Automatic Identification System (AIS) the maximum risks of traffic accidents or illegal discharges from ships are concentrated in the main ship traffic route to the port of Baltiysk at the south-western edge of Sambia Peninsula (Fig.1). The peninsula is located between the Curonian and Vistula Lagoons. Two seacoasts of the peninsula are intensively eroding nowadays. There are rapidly developing seaside resorts here: Svetlogorsk, Zelenogradsk, and Yantarny. Illegal discharges of oil products are constantly detected from satellites on Synthetic Aperture Radar (SAR) images. Long-term satellite monitoring indicates a large number of oil slicks near the Baltiysk [5].

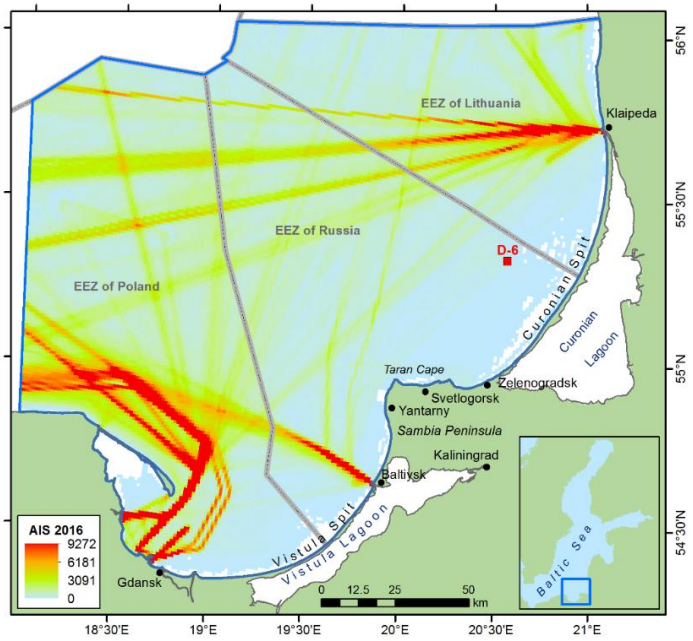


Fig. 1: *Density of all ships operating in the Baltic Sea in 2016 based on HELCOM AIS data, and offshore platform D-6 location (©HELCOM)*

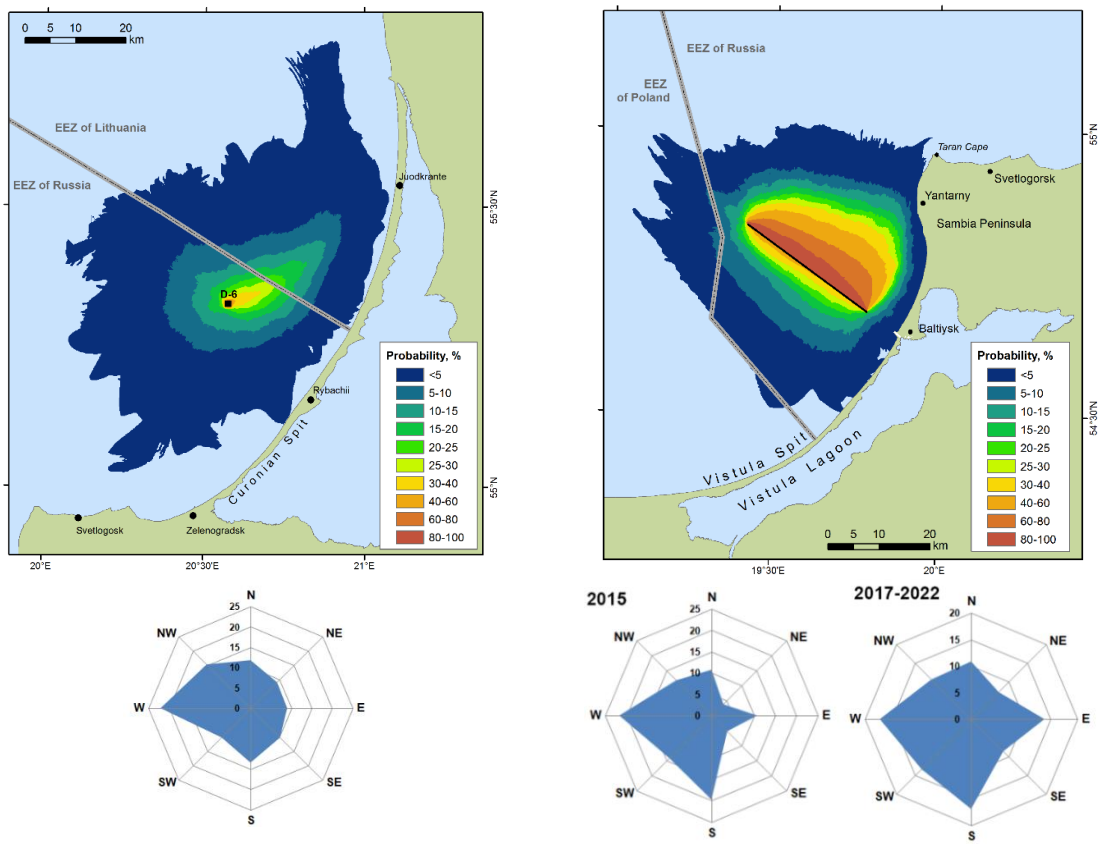
Propagation of a potential oil spill were calculated using Seatrack Web (SMHI, HELCOM) (https://stw.smhi.se/) daily for 48 hours ahead from point potential source (platform D-6) for period covering 2017-2022, and elongated potential source (main ship traffic route to the port of Baltiysk) for period covering 2015. The initial release volume for all scenarios was 100 m^3. Combining the results of daily forecasts of oil spreading made it possible to obtain integral patterns of potential pollution of the sea surface, on the basis of which the probability of pollution of coastal area was estimated.

III. Results and discussions

The probability that oil pollution of a given volume from offshore platform D-6 will reach the coastal zone of the Curonian Spit for the meteorological conditions of 2017-2022 turned out to be small (<5%). However, according to the simulation results, it turned out that the middle part of the Curonian Spit was the most oil-prone part of the coastal zone and coast (Figure 2a).

The shape of the potential (hypothetical) oil pollution probability field shows some discrepancy with the wind rose. With a clear predominance of westerly winds, the most probable direction of oil drift turned out to be not the expected eastern, but the northeastern direction. The reason for this discrepancy, apparently, is the distorting influence of coastal water dynamics [6, 7]. It is especially noticeable in the region of low pollution probabilities on the southern and northern periphery of the resulting oil pollution distribution area.

The northeastern direction of potential oil pollution transport was predominant in the area of the main ship traffic route to the port of Baltiysk in 2015. The coast of almost the entire Russian part of the Vistula Spit and the west of the Sambia Peninsula was under a small threat of oil pollution (Figure 2b). This is consistent with the predominance of southerly and westerly winds. In contrast to the area of offshore platform D-6, the probability field obtained here for potential oil pollution of the sea surface is statistically less secure. Based on the wind rose for 2017-2022, obtained according to the data from weather station in Baltiysk (Figure 2b), the trend of oil pollution propagation in this water area will remain the same.



(a) (b)

Fig. 2: *Probabilities of hypothetical oil pollution propagation within 48 hours based on Seatrack Web (SMHI, HELCOM) model results from potential sources:*
a) D-6 oil platform (2017-2022), b) main ship traffic route to the port of Baltiysk (2015)
Wind roses are given according to meteorological station on D-6 (a) and from Baltiysk (b)

The sensitivity of the coast and coastal area is largely dependent on the physical character of the environment. When assessing the impact on the coast and the coastal zone to possible oil pollution, it is necessary to take into account not only the value of habitats, but also the morphological and lithological characteristics of the underwater coastal slope and coast. This is of particular importance for the sea coast of the Curonian Spit National Park.

The coast at the Curonian Spit is mainly flat. Although there are some parts of intensive erosion present, the sandy beaches are mainly flat with bigger or lower amount of gravel. These are easily permeable sediments and their pollution will lead to long-term negative environmental impacts. Shoreline of the Curonian Spit is unsheltered, facing highly dynamic wave regime and intensive alongshore sediment transport. The beaches are composed of fine and medium-grained sand mainly, but the near shore is much more lithologically diverse. The hard bottoms, clay outcrops and gravel fields present near the shore creates the specific conditions for local biotopes to establish. In order to complete the precise evaluation of near shore and coastal area sensitivity to possible oil spills there is a need to identify vulnerable coastal sectors and complete detailed mapping of underwater landscapes [1].

IV. Summary

The results of the potential (hypothetical) oil spill drift forecast using Seatrack Web (SMHI, HELCOM) from two main potential sources of oil pollution of the coastal zone of Kaliningrad Region (Russian Federation) showed a low probability of oil pollution of coast. Nevertheless, the most prone to such pollution areas of the coastal zone and coast have been identified. These are the middle part of the Curonian Spit (for 2017-2022), the distal part of the Vistula Spit and the entire western coast of the Sambia Peninsula (for 2015). Analysis of environmental risks proved to be an effective tool for regional oil spill response planning.

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